New Constraints on Tectonics of Interior Alaska: Earthquake Locations, Source Mechanisms and Stress Regime

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The tectonic framework of Alaska is dominated by subduction of the Pacific plate underneath the North American plate. Stresses due to the plate convergence are transmitted across great distances into interior Alaska where the deformation causes substantial crustal seismicity. While some of the earthquakes are clearly associated with the large-scale strike-slip fault systems of Denali in the south and Kaltag and Tintina in the north, the majority of the shocks are located in a zone of distributed shear deformation between the two fault systems. These earthquakes are aligned in north-northeast trending zones. Page et al. (1995) suggested a block-rotation model to characterize the deformation in interior Alaska. In this model, the crustal blocks are rotating clockwise in a dextral shear zone between the Denali and Tintina fault systems.

We used the Joint Hypocenter Determination method to relocate 3,611 crustal earthquakes that occurred from 1988 to 1999 in interior Alaska. The new earthquake locations provide more details on the structure of the Kantishna cluster and better locations for the aftershock sequence of the 11/29/2000 M_L 5.6 earthquake in the Minto Flats seismic zone. The JHD locations for the aftershocks of the 1995 M_W 6.0 Minto Flats earthquake and 10/22/96 M_W 5.7 earthquake near the Denali fault are also available.

A catalog of 196 fault plane solutions consisting of the moment tensor solutions for the earthquakes with magnitude 4.0 or above and P-wave first motion solutions for the earthquakes with magnitude 3.4 and above that occurred from 1988 to 2000 is composed for interior Alaska. Moment tensor solutions are calculated using regional broadband data. This catalog has been used to calculate principal stress orientations in the crust. The stress orientations change systematically across central Alaska. In particular, the maximum principal stress orientation rotates clockwise from SE-NW to SSW-NNE direction as one moves from west to east across central Alaska. These stress orientations are consistent with the stress field transferred from the plate convergence in southern Alaska.

Analysis of the fault plane solutions for the earthquakes within the Minto Flats seismic zone shows that the predominant orientation of the fault planes changes across 64°N latitude from a southwest-northeast orientation north of it to a south-southwest-north-northeast orientation south of it. This change coincides with a change in the earthquake alignment. The earthquakes form a coherent southwest-northeast oriented lineament north of 64°N latitude, while the seismicity is more diffused south of it.